ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 4

ELECTROSTATIC EXPERIMENTS

RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION OF AMERICA
HOME STUDY SCHOOL
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Experiment Lesson 4

OBJECT

The object of the experiments in this lesson is to confirm the following statements made in Theory Lesson 4.

1. All substances in their natural state, with no pressure applied to them, are electrically neutral in charge.

2. It is possible to produce a positive or negative charge by rubbing one substance with a different substance.

3. Like charges repel each other and unlike charges attract each other.

INFORMATION

To prepare for these experiments, read and study Theory Lesson 4. The proper time to do these experiments is when you are fairly sure that you understand the Theory Lesson. If, during an experiment, something puzzles you, go back to the Theory Lesson and look for the answer there.

These experiments are based on materials you have right in your own home. They are best performed in cool, dry weather. Otherwise, weather conditions may make it almost impossible to produce enough static electricity to do them. For, when the air contains a lot of moisture, a charge may leak off as fast as it is produced. There's nothing anyone can do about it.

METHOD

Weather permitting, the object of this lesson will be achieved by:

1. Testing materials to find out if any charge exists *before* an attempt is made to produce one. This is done by trying to attract small particles or a paper ball with a material in its natural state.

2. Testing the same materials for the presence of a charge *after* an attempt is made to produce a charge.

3. Producing like charges and unlike charges to test for repulsion and attraction. This is done by charging two like bodies, and later, two unlike bodies – suspending one of them so that it may move freely, approaching it with the other, and noting the result.

PART ONE

EQUIPMENT NEEDED

Neon bulb (from Kit 2)

A grounded surface

A rug or carpet

The grounded surface may be a cold-water pipe or faucet, a steam or hot-water radiator, an indoor water-pump spout, a radio ground lead, or some other metal conduit or pipe that is connected to the ground.

EXPERIMENT 4-1

To charge your body and discharge it to ground.

Procedure.

Step 1. Locate the nearest grounded surface. If possible, it should be in a room

with a carpet or rug on the floor. From now on, we'll call it the *ground*.

Step 2. Stand near the ground, without touching it, for one minute. This is to give your body a chance to get rid of any charge it may have picked up on the way to the ground.

Step 3. Now touch the ground with your finger. When you touch ground, you should feel nothing but the metal surface of the ground.

Step 4. Walk back and forth across the carpet or rug, dragging your feet a little, and approach the ground.

Step 5. Immediately touch the ground. If the weather is favorable, you should feel a slight tingle as your finger touches the metal. If you do, repeat the experiment. This time, watch closely and see if you don't see a small flash or spark as the electric charge leaves your finger and is grounded.

EXPERIMENT 4-2

To charge your body and discharge it through a neon bulb to ground.

Information. In Experiment 4-2, you will use the small neon bulb that was sent to you in Kit 2. Be careful in handling this neon bulb, because it is easily broken. Later, you will learn why it is that neon bulbs glow. Right now, it is a little too soon to talk about the theory involved. However, it is very important that you know that about 75 volts of electrical pressure between the two leads of the neon bulb are required for it to glow. Therefore, if the neon bulb glows in the experiment that you are about to perform, you can be sure that the difference in potential that exists between your body (which you will charge electrically) and ground is at least 75 volts.

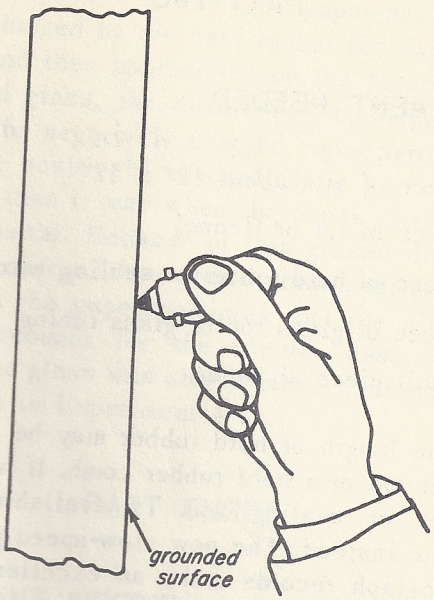


Fig. 4-1

CAUTION. Do not connect the terminals of your neon bulb across the terminals of any electrical outlet in your home or shop. If you do, you may burn it out. Later in this course, you will need it in order to perform other experiments.

Procedure.

Step 1. Make sure that your body is not charged by touching the metal surface of the ground.

Step 2. Charge your body as you did in Experiment 4-1.

Step 3. Hold the neon bulb by the metal band, as shown in Fig.4-1. Touch the grounded surface with the contact on the bottom, and, at the same time, look at the neon bulb. If the weather and atmospheric conditions are favorable, and you have been able to charge your body, the neon bulb will glow for a moment. If you are not successful the first time, try again. If the weather is moist and humid, you may not be able to do this experiment. Wait for the first cool, dry day. Then conditions for performing this experiment will be better. Try this experiment then; you may be more successful.

PART TWO

EQUIPMENT NEEDED

Piece of silk about 12" x 12"

Piece of fur or flannel

Piece of hard rubber or sealing wax

Piece of glass rod or glass tubing

Small piece of paper

The length of hard rubber may be a hard rubber rod or a hard rubber comb. If no hard rubber or sealing wax is available, use plastic instead. The new slow-speed plastic phonograph records make an excellent substitute for hard rubber or sealing wax. A small glass bottle, thoroughly dry, may be used instead of a glass rod or glass tubing.

EXPERIMENT 4-3

To attract small paper particles with charged materials.

Procedure.

Step 1. Cut the piece of paper into very tiny pieces (1/8" squares or smaller). Place some of the paper particles on a dry, non-metallic surface, such as a wooden table top, a sheet of linoleum or glass, or a sheet of paper.

Step 2. Touch the paper particles with the hard rubber. Nothing should happen.

Step 3. Touch the paper particles with the glass. Nothing should happen.

Step 4. Rub the piece of hard rubber (or the substitute you're using) with the piece of fur or flannel, as shown in Fig. 4-2.

Step 5. Immediately bring the free end of the hard rubber close to the paper particles, but do not touch them. Either some of the particles will be attracted to the rubber and jump up to meet it, or some of the paper particles will stand on edge, but will not quite make the jump to the hard rubber. Of course,

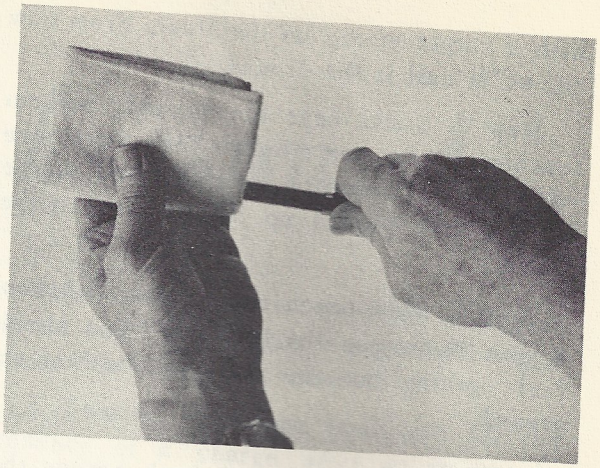


Fig. 4-2

there is a third possibility – that nothing happens. If so, try again. If it doesn't work the second time, try a piece of plastic – one of the new plastic phono records, if possible.

Step 6. Now rub the glass briskly with the piece of silk.

Step 7. Immediately place the glass near a fresh supply of the paper particles and see what happens. The particles should be attracted to the glass.

EXPERIMENT 4-4

To learn what attraction oppositely charged bodies have on each other.

Procedure.

Step 1. Rub the hard rubber with the fur and directly touch some of the paper particles with the rubber. In rubbing the hard rubber with the fur, electrons are wiped off the fur and onto the hard rubber. As a result, the hard rubber has an excess of electrons and so is negatively charged. When the negatively charged rubber touches the paper particles, the particles become negatively charged by *conduction* (by actual contact).

Step 2. Next, rub the glass with the silk and approach the same paper particles with the glass. The silk wipes off electrons from the glass and leaves the glass positively

charged. Approach the negatively charged paper particles with the positively charged glass. The paper particles should jump up to meet the glass more readily than they did in Step 7 of Experiment 4-3, as shown in Fig. 4-3.

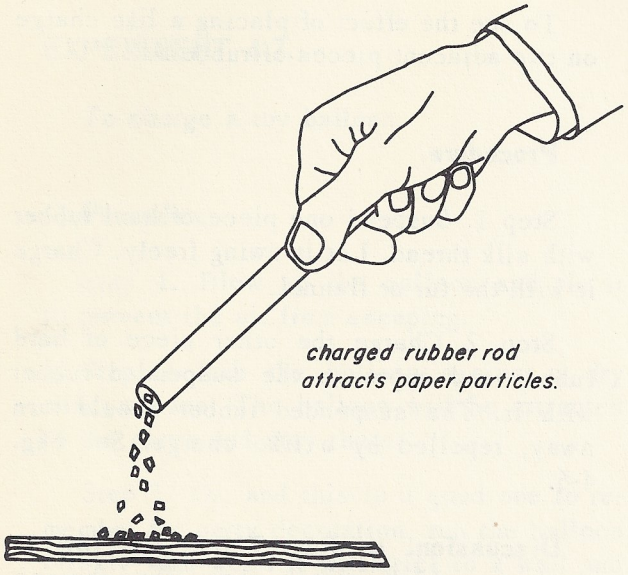


Fig. 4-3

Discussion. The reason that the positively charged glass attracts the paper particles more readily in Experiment 4-4 than in Experiment 4-3 is not hard to find. Let's think it out.

First of all, in Experiment 4-3, when the negatively charged hard rubber approaches the paper particles, the particles are electrically neutral (they are not positively or negatively charged). So, the amount of attraction between the hard rubber and the paper particles depends upon the amount of charge on the hard rubber (on the amount of electrons that were wiped off the fur onto the hard rubber). When the glass was rubbed with silk in Step 6 of Experiment 4-3, electrons were wiped off the glass, leaving it positively charged. Then, when the positively charged glass approached the paper particles, the paper was neutral, so that the attraction that the glass had upon the paper particles depended on the amount of positive charge on the glass (the number of electrons wiped off the glass by the silk). However, in Experiment 4-4, when the paper particles were charged by the hard rubber (by conduction) and then approached by the positively charged glass, the difference in charge between the negatively charged paper particles and the positively charged glass was much greater than it was when the paper particles were neutral. Because of this greater difference in charge, there was a greater attraction between the paper particles and the glass. This accounts for the greater ease with which the glass was able to attract the paper particles in Experiment 4-4.

PART THREE

EQUIPMENT NEEDED

Same as in Part Two, with the addition of some silk thread and a paper napkin or a piece of paper tissue.

EXPERIMENT 4-5

To charge two adjacent paper balls by conduction and see the effect that they have upon each other.

Procedure.

Step 1. Roll two 3" x 3" pieces of tissue paper into two tight balls. Tie each of these paper balls to a two-foot length of silk thread.

Step 2. Hang one of the balls from some convenient place, where it may swing freely without touching a wall or other object.

Step 3. Charge the hard rubber with the fur.

Step 4. Immediately approach the suspended paper ball with the charged hard rubber. The ball should be attracted to the hard rubber, as shown in Fig. 4-4. Charge the ball by letting the hard rubber touch it.

Step 5. Recharge the hard rubber and again approach the ball. The ball, being negatively charged, should now be repelled.

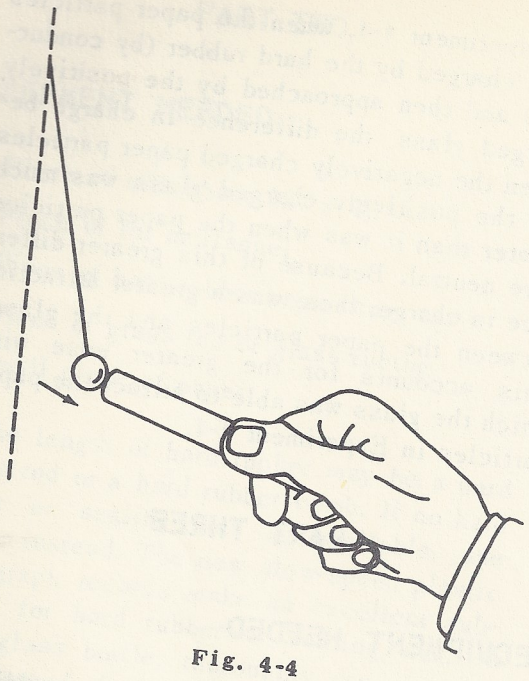


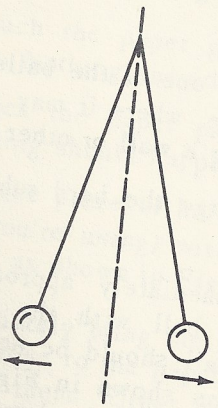
Fig. 4-4

Step 6. Hang the second paper ball so that the two balls are about an inch apart.

Step 7. Recharge the hard rubber and charge the second paper ball by touching it with the rubber. The two balls, each negatively charged, should repel each other, as shown in Fig. 4-5.

Step 8. Charge the glass rod with the silk.

Step 9. Charge one of the paper balls with the charged glass. Now one of the balls is positively charged and the other is still negatively charged. They should attract each other. If the experiment doesn't work out the first time, try again.



Two identically charged paper balls repelling each other

Fig. 4-5

EXPERIMENT 4-6

To see the effect of placing a like charge on two adjacent pieces of rubber.

Procedure.

Step 1. Suspend one piece of hard rubber with silk thread. Let it swing freely. Charge it with the fur or flannel.

Step 2. Charge the other piece of hard rubber and approach the suspended rubber with it. The suspended rubber should turn away, repelled by a like charge. See Fig. 4-6.

Discussion. In Part Three, the law of charges, which states that like charges repel each other and unlike charges attract each other, is confirmed. In this part, weather permitting, you found that when both paper balls were charged negatively, they repelled each other; and that when one was negatively charged and the other was positively charged, they attracted each other.

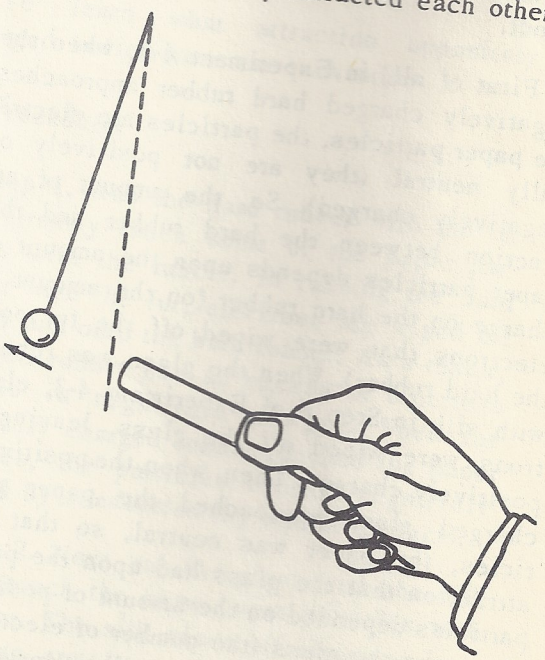


Fig. 4-6

PART FOUR

EQUIPMENT NEEDED

One toy balloon.

EXPERIMENT 4-7.

To charge a toy balloon.

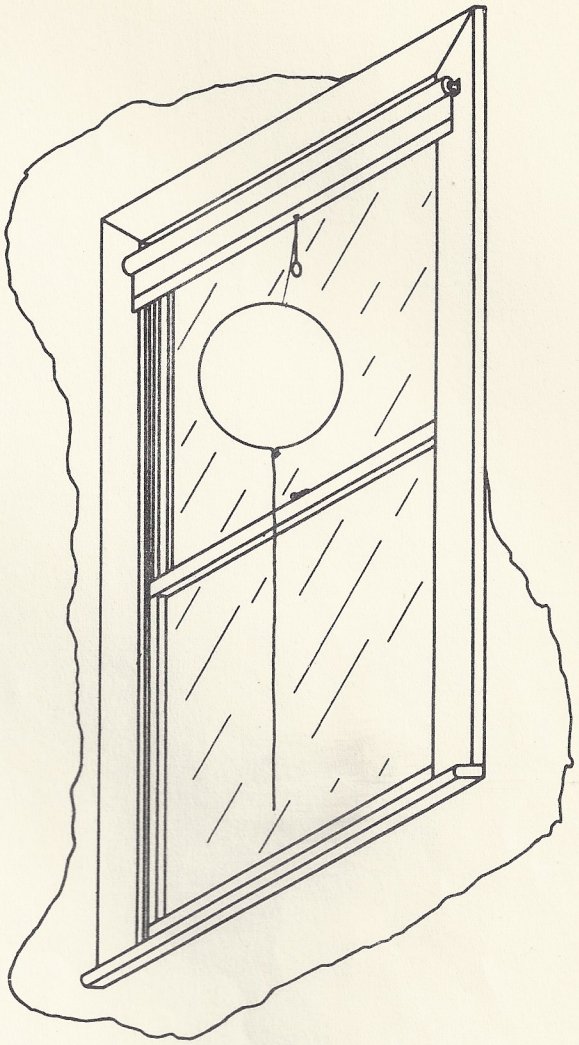
Procedure.

Step 1. Blow up the balloon and tie it to prevent the air from escaping.

Step 2. Rub the balloon against a dry window pane. The balloon will be attracted to the glass and stay there.

Step 3. Or, and this is a good one to remember for party decoration, rub the balloon briskly with wool. It will stick to a wall and stay there.

Discussion. In the experiment where the toy balloon is rubbed against a dry window pane, the glass and the balloon became oppositely charged and so were attracted to each other. From the experiments discussed in this lesson, can you think of a way by which you could tell whether the balloon becomes positively charged or negatively charged?



Charged balloon attracted to window pane

Fig. 4-7